ENERGY AS A DEVELOPMENT PREREQUISITE FOR ECONOMIC AND SOCIETY*)

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ABSTRACT

The concept of energy as a development prerequisite is discussed in view of its role in Indonesia; a large country endowed with rich natural energy resources, with a dominant rural population. Renewable energy resources and their utilization is reviewed. Lessons can be obtained from typical income-generating energy projects which is relevance for the small and medium scale enterprises. A study or model of energy use in Indonesia using a market allocation approach is noted, in which its relationship with air pollution issues are analyzed. The allocation of energy resources in Indonesia has the characteristics of a multidimensional problem. This is difficult to be resolved satisfactorily, as we know that this is part of a wider picture of the national development. The strategy includes people-centered initiatives, in anticipation of the open, competitive market in this globalized era. This paper discusses also the implication of energy technology development to the Indonesian energy economics. Basic issues related to the research capability, the priorities, and the allocation of resources for research and development in Indonesia are also reviewed.

Keywords: *Indonesia; renewable energy resources; income-generating energy projects; model of energy use; air pollution; energy technology development.*

INTISARI

Konsep energi sebagai salah satu prasyarat pembangunan dibahas dalam kaitan dengan peranannya di Indonesia; Sebuah negara besar yang dikaruniai kekayaan bermacam sumber energi dan yang sebagian besar penduduknya berdiam di pedesaan. Sumber-sumber energi terbarukan dan pemanfaatannya akan diungkap. Pelajaran dapat dipetik dari uraian tentang beberapa projek energi yang dapat digunakan sebagai sumber penghasilan bagi pengusaha kecil dan menengah. Kajian singkat tentang pemanfaatan energi di Indonesia berdasar pendekatan alokasi pasar diutarakan keterkaitannya dengan isu pencemaran udara. Pemenuhan kebutuhan energi merupakan karakteristik yang multidimensi. Hal ini sulit untuk dipecahkan secara memuaskan, karena sebagaimana diketahui masalah ini merupakan bagian dari masalah yang lebih luas dari pembangunan nasional. Strategi tersebut memasukkan manusia sebagai titik pusat bahasan dalam menghadapi era globalisasi yang penuh tantangan persaingan dan keterbukaan. Tulisan ini juga menyinggung masalah implikasi pengembangan teknologi energi ekononomi di Indonesia. Issue dasar yang terkait dengan kemampuan penelitian, prioritas, dan alokasi sumberdaya untuk penelitian dan pengembangan di Indonesia juga diulas.

INTRODUCTION

Studies on the Indonesian economy show that during the seventies the Indonesian economy was in constant adjustment to the change management caused by the fluctuating and ever changing international oil prices, and in the eighties the situation was reversed. This was the decade that Indonesia was forced to seek alternatives, in line with the declining oil price[1]. The time period of 1967-1988 is known to be the time of shocks in oil prices: (1) the 1973-1974 oil price increase; (2) the 1979-1980 oil price increase; and (3) the 1984-1986 decline in oil price.

Energy-related R&D in developing countries was being addressed as a special topic by the Energy Research Group[2] fifteen years ago. This group considered basic question such as those related to the research capability, the relevance and accessibility, the priorities, and the allocation of resources for energy research. Obviously this topic covers a very wide area, and has many implications at the national, regional and international scene.

In the context of Indonesia, during about the same time period, Peter Mc Cawley and Anne Booth[3] focused their attention on the oil boom in the Indonesian economic policy and performance in the 1970-1990 period. They reviewed and edited a series of research papers on aspects of the development of the Indonesian economy. Major changes since then encouraged them, with the availability of the newly published reliable statistical data form the *Biro Pusat Statistik,* to publish it[4].

It is generally accepted that energy, being at the center of the environmental issue, has to be seen also in the context of the environmental degradation as a result of over-exploitation of natural resources. Consideration should be given to the exchange of information and to make available to the developing countries appropriate and environmentally sound technologies, in order to assist them to adjust to the new global, regional, and local environmental conditions. This is of course a difficult subject to discuss and also part

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of a new approach in building modern Indonesia in the globalization era.

The Scope of this paper might relatively be too broad for JKTI, but by having consideration that the role of chemistry and chemical research is very important for energy development, this energy issues overview could be a beneficial input for JKTI's reader.

POVERTY ISSUES

Since the early 1970's the Indonesian national development was characterized by its very high economic growth. This growth was accompanied by various gaps, notably interregional: between the eastern part of the country and the western part, inter-sectoral: between rural and urban, and social: between the poor and the rich. The problem was the very large population being in the absolute poverty status, whether measured using the rice-equivalent income as the poverty line of the Indonesian Central Bureau of Statistics or the welfare categories as the defined and introduced by the National Coordination Agency for Family Planning.

Those poor people who are still close to the poverty line are susceptible to be caught in the poverty trap, remaining in the poverty band and hence unable to live descent lifes. They belong to a group of the have-nots and yet, of course, have the rights for social justice and equitable development. They should not and can not be treated as 'productive units' , which will be an active part of the national economy. A large proportion of the poor needs assistance to survive, and are therefore beyond the reach of the normal credit schemes to enable them to have a better future.

In the long term, one realizes that access to the physical assets, such land and other productive factors is important. On the other hand the non-physical assets comprising skill and education, values, and attitudes will be the real capital for the betterment of the conditions of the poor.

In general we know that a significant step toward improvement can only takes place in the society which has (1) educated members, (2) organizational set-up and (3) high social discipline. This the challenge in a multi-dimensional problem of poverty. We know that human poverty is more than income poverty; it is the denial of choices and opportunities for living a tolerable life[5].

Credit is vital to the poor, yet it seldom reaches them because they lack the collateral to raise money[6]. The lengthy bureaucratic procedures of most banks also constitute obstacles. In response, community credit efforts have emerged which offer the rural and urban poor new opportunities to acquire the resources they need to regain control over their lives. Most credits schemes for rural and urban women have initiated a number of income generating activities. One of the major lessons is that no credit scheme is 'the best' to reach the poor in all situations. Local needs, aspiration, skills, cultural, socio-economic and political system differ and should therefore be taken account of in the design of the programs.

COMMUNITY DEVELOPMENT

The discussion on poverty leads us to a more critical look into the issue of rural development or community development. Various successfully conducted studies and policies developed were the basis of various schemes in development programs. However, a long-term implication of these policies are difficult to ascertain. In modeling we are aware and reminded of the counter-intuitive behavior of social systems. Forrester[7] identified three characteristics of a social system, which can mislead one in the process of decision making and concluding observations and studies:

- social system are not sensitive to changes in policies with respect to change and to improvement in the behavior of the system
- factor that may be influential and sensitive may somehow not be expected to be changed
- conflict between short-term and long-term results that may arise as a consequence of implementing a particular policy

A computer system dynamic model for community development in remote areas in Indonesia provided the basic information on various underlying factors behind the change management in rural development[8]. This study enables one to analyze sets of policies with regard to the issue of bringing the rural communities into a modern society, a civil society with its base in (1) small and medium scale enterprises, (2) natural resources based industries, and (3) integrated land-ocean-based development.

It is concluded that energy would be playing a dominant role in the process, both qualitative-as well as quantitatively. The energy supply and demand would then be a major definite driving factor in the modernization process of rural Indonesia. The 'connecting' mechanisms are synthesized from the variables:

- traditional food and the shift to rice; rice being a mix of staple food and cash-crop
- new production processed in agriculture: pre-and post-harvest, from basically manual to semi-mechanized agricultural technology
- new food industrial product and their marketing
- new resource allocation and paradigms.

NON-CONVENTIONAL ENERGY RESOURCES

An important issue that was of considerable interest in the scientific community dealing with energy research in developing countries is energy policy. Nurul Islam[9] examined all aspect related to rural energy. Energy transition is the process whereby the volume and proportion of commercial energy increases so as to replace traditional fuels as the main energy source. Findings in the research can be summarized as:

- the proportion of traditional energy consumed for cooking falls when income rises;

- major energy transitions are taking place in urban areas and in rural areas in Indonesia;
- the choice between several kinds of energy also depends on supply condition and their availability;
- it was also concluded that in the early eighties the amount of wood and waste materials consumed will not decline over time, but increase.

The merging of two journals, namely *Journal of Energy in Agriculture* and *Biomass* in 1988 shows the shift in the role of biomass. Formerly *Biomass* only considered research papers dealing with biomass (1) as feedstock; (2) aspect of its biochemistry; and (3) aspects of thermo-chemistry. With the merging, biomass is now also part of the energy system. Trees are being looked at from its non-seed carbohydrates in energy plantation, directed as non-food plant.

In southeast Asia the tradition has a relatively long history; in Sarawak from the 1920s alcohol as fuel from palm juice was already known. Theoretically from one kilogram of sucrose one can get 0.65 liter of ethanol, whereas by hydrolysis, from one kilogram of sago 1.10 kilogram sucrose can be obtained, or 15 MJ from 1 kilogram of sago. This process is of course not for immediate implementation at the rural level; it is not simple, as one has to consider energy balance, and other basic variables, making the whole conversion process a subject of further (still) basic research.

Another interesting result of research on solar energy was on solar insulation data. Chang[10] in his study showed, and later verified in various measurement, modeling and data analysis, that the potential net photosynthesis in g/m^2.day in the tropics is 25% lower than that from the temperate zones. This climatic dependence of output on latitude was determined by analysis of temperature and solar radiation records from 386 stations throughout the world. Furthermore in the tropics, using rain fed rice cultivation, Indonesia will have rice cultivation with only four months of potential photosynthesis in one year compared to an eight-month potential in the temperate zones for wheat and other crops. It will also be interesting to note that java, lying just south of the equator has in fact some nine percent higher mean value (27 g/m^2.day) than the corresponding region just north of the equator, which has the lowest potential photosynthesis on earth (24 g/m^2.day).

In the direct and indirect use of solar energy, the progress of the utilization of solar energy was not as it was hoped for, following the technology development and innovation, which has brought this development into the market in the early eighties.

ENVIRONMENTAL CONSIDERATIONS

A study or model of energy use in Indonesia using a market allocation approach was conducted and subsequent air pollution issues analyzed[11]. An air quality management plan was proposed which has a time schedule for implementation in three stages according to urgency. The control measures are (1) very high priority: SPM (= suspended particulate matter) and Pb reduction, (2) high priority: NO_x and VHC (= volume hydrocarbons)reduction, and (3) moderate priority: SO_2 reduction. The introduction of energy technologies (fossil and renewable), which inherently produce less pollutants is recommended as these technologies offer environmental advantages with regard to these emissions.

RURAL ELECTRIFICATION

In the field of electrification, in Indonesia the rural electrification project has changed the rural picture. In 1993 16.786 Javanese villages (72.3% of villages in Java) and 15.861 outside Java (43.5% of villages outside Java) are supplied electricity from the national grid[12]. However the impact of this on firewood consumption is not known; at least there are only a few studies conducted, with no known national implication examined. The question raised at the rural level is however still: "Is rural electrification a catalyst for development or does it accentuate rural inequality, since it first goes to wealthy households".

With respect to agriculture, small-scale industries, social change and poverty alleviation we know now that:

- rural electrification offers substantial opportunities for agricultural development by way of electrical pumps for irrigation;
- it may contribute to the establishment and survival of rural businesses;
- although higher income household are the first to be connected, rural household in general benefit, women and children more directly than men; and
- its positive impact may be determined more by government policies and unique regional characteristics than by the technology itself.

Next, will be elaborated the other end of the spectrum of the energy research, namely fuel-cell technology.

FUEL CELLS: NEXT-GENERATION ENERGY TECHNOLOGY[13]

Materials science and technology plays an important role in the development of fuel cell fabrication. Computational and modeling methods, material purification techniques, materials engineering having advanced very rapidly, now allowing one to choose and seek optimum materials composition, in the form of pure materials, alloy or compound.

S&T development has assisted the development of electro-chemical devices in combining the right materials, cheaper, and available, so as to reduce the cost of constructing the device. Production cost reduction is the single most important objective in the production of fuel cell or system, so that the energy output (electricity) can compete with other energies generated conventionally. It is now regarded that a competitive fuel cell-generated electricity is feasible now. The lifetime of the cell is also

lengthened, with a working life of 50 up to 100 thousand hours of cell generating 100 kW and a rate of voltage degradation of one percent per one thousand hours.

Materials processing technology using thin-film technology, ceramics technology, powder metallurgy, electrochemistry, and also measurement techniques are the essential core competencies built over the years that will enable the Indonesian researchers to make their contributions to the development of the upcoming energy technology. They are individual top scientists in the country with little experience in group research, but individually having sufficient exposure to the international scientific community.

A scheme of *Riset Unggulan Strategis Nasional* (RUSNAS = national strategic high-rank research) is the proposed organization to achieve this excellence and at the same time attract the private sector and the industries to join in this focused effort in energy development in Indonesia. This team, at the core of the research, 29 scientists and engineers, forming coordination of seven groups: (1) Modeling; (2) Electrodes; (3) SOFC (=solid oxide fuel cell); (4) Materials; (5) PEFC (=proton exchange fuel cell); (6) Characterization; and (7) Fuel Processor. The projection is for an energy supply in Indonesia of electricity reaching around 2000 GWh five years from now.

RESEARCH IN INDONESIA: A MANAGEMENT PERSPECTIVE

One of the tasks of the Minister of State for Research and Technology is to assist the President in outlining a policy the government has to carry out in utilizing, developing and mastering science and technology to meet the needs of national development. To fulfill the task, the document of Strategic Policy of National Science and Technology Development 2000-2004 is issued to be used as s guideline in our efforts to capitalize on facilities offered by science and technology.

The strategic policy of national science and technology development is intended to be a guideline for Indonesian people to harmonize all of their actions in the utilization, development and mastery of science and technology to support the national development. Supports to the development that emerges from the increased research, development and engineering activities for the establishment of the national innovation system, will indeed require similarity in understanding and integrated action of all. Therefore, the innovation system will become a competitive asset to be owned and understood by the nation.

It is based upon the reality that the Indonesian nation is urgent to integrated itself with foreign nation in mastering science and technology. The need to promote such capability is driven by the increasing progress of world's science and technology, which in turn, otherwise, will complicate ours effort to develop nation's self reliance and excellence. Therefore various effort and activities are aimed at increasing the capabilities of practitioners and user of science and technology. In parallel with this, it requires efforts to develop institutions, partnership, programs, facilities, and system as well as to socialize the science and technology, with a target of a clear measurement of success. In addition, at the some time, the efforts are intended to strengthen the sense of togetherness among technology user at the national level to develop and master science and technology for creating new employment and increasing the welfare of the nation.

According to the principle that underlines the introduction of this policy, all aspects of the strategic policy of science and technology development has so far been adapted to the policies from other related sectors. However, to anticipate the increasing development and changes that might happen, this formulated policy has been made flexible and open in nature as well as applicable to every possible condition in the future.

The Indonesian Science and Technology Strategic Policy 2000-2004 (*Jakstra Ipteknas 2000-2004*)[14] is intended to become a guideline for the utilization, and mastery of science and technology to support national development. The policy is aimed to open opportunities for using the new devices in most of implementation activities for the development of science and technology in Indonesia. Therefore, this policy attempts to provide basis and direction for a more defines science and technology development and determines approaches believed to be sustainable fruitful.

The implementation of science of technology development will be focused on efforts incorporate research, development, and engineering activities as in integral part of the national development, so it emphasizes on the provision and adoption of **innovations** which will significantly promote and sustain national production underlined by a stable social environment. Thus, the activities should be based on a real demand, and as a system, all of them will anchor at the society and its culture. This mean to build up the capacity of recognizing the strengths and weaknesses of all collaborating players, while human resource as practitioners become the main factor who plays a very important role. However, the effectiveness of its utilization is strongly dependent upon performance and synergies that occur in the institutional network system, in which the activities are related to creating, developing, and transferring of science and technology as well as their utilization in economic activities.

Improvement of science, development, and engineering activities for the **establishment of the National Innovation System** is to achieve the vision of national science and technology development, *i.e Establishing a wealthy Indonesian Society with dynamic civilization based on their ability to utilize, develop, and master humane science and technology, to support the development of fair nation's lives and clearly improve the quality of life and perseverance of environment and natural resources, to ensure their sustanaible utilization.* The efforts to achieve this vision are conducted through implementation of strategic objectives of national science and technology development which include:

1. **Dynamism of Developmental Momentum**: utilization of all science and technology resources to alleviate the impact of the current economic crisis and to revitalize the developmental momentum.
2. **Socio-Political Conditioning**: the assessment of various paradigm changes and analyze the structural and institutional weaknesses that must be continuously overcome in the effort to strengthen a foundation for the national development.
3. **Sustain of The Economic Development**: strengthening and increasing the effectiveness of science and technology support for national development by increasing the incentives to improve the structure of the national production.
4. **Repositioning of the Science and Technology Institutions**: to place science and technology institutions strategically in the planning and executing the national development.
5. **The Enhancement of Self-reliance and Excellence**: to improve the capability for assimilating science and technology and developing the innovative capability as foundation of develop self-reliance and excellence
6. **Compatibility with Global Development**: to provide support of science and technology to extend capability in managing every other thing pertaining to the global concern and trend, and enlarge the compatibility of the national development with global development.

In their implementation, *the Jakstra Ipteknas (2000-2004)* focuses on human resource development; utilization, development and mastery of science and technology; and promoting research, development and engineering activities to support national development especially the partnership and empowerment of small and medium enterprises. Meanwhile, in line with the objectives and the focus interest of *the Jakstra Ipteknas (2000-2004)*, the research, development, and engineering activities performed to support following fields need to be prioritized.

1. **The Social and Culture**: impact of technology to behavior, central and regional relationship, mass support to the science and technology based-development, anticipate and overcome social-political conflicts in sensitive areas.
2. **Development of the National-Sectoral-Regional System**: structuring of system of tourism, traditional trading and market, national science and technology, national innovation and other system.
3. **Agriculture and Food**: including agronomy/horticulture, plantation, forestry, fishery, and husbandry, which all of them involve biotechnology.
4. **Health**: the development of instrument, strategic tools and material for medicine – completion of contraceptive technology – the protection of the infectious decease, nutritional and mental disorder – the development of biopharmacy – all involve the biotechnological supports.
5. **Environment**: the monitoring, analysis, remedies of clean technology and control of pollution – the utilization, reuse, recycle and recovery of sewage.
6. **Marine, Lands and Space**: maritime industry, water, mining and natural resources, climate, biosphere-atmosphere interactions interaction, natural disaster, remote sensing information system.
7. **Transportation and Logistics**: development of system and facility in land, sea and space.
8. **Energy**: economic efficiency, storing, transmission, distribution.
9. **Manufacture**: mainly for small, medium industries and cooperatives: precision, simulation, and modeling, controlling, production management including the marketing.
10. **Information and Microelectronics**: development of system and hardware and software, utilization.
11. **New Materials**: ceramic, composite, polymer, high performance substances.

Considering the priority of the above-described fields, it is expected that after a certain period they will become the main locomotive and backbone of social-economic development which in turn contribute directly to the national development.

The success of science and technology development should be assessed through the achievement of all strategic objectives. Selected important performance factors to be monitored and evaluated during implementation of *the Jakstra Ipteknas (2000-2004)* are as follow:

a. Capacity building on innovation and diffusion of technology in industrial sectors
b. Promoting the development of technologically-based small and medium scale enterprises and cooperatives at central and regional levels.
c. Supervising the partnership on science and technological research among small, medium and big industries.
d. Intensifying the science and technology activities at regional level.
e. Developing the service system and technology information; Intellectual Property Right, Metrology, Standard, Testing and Quality (MSTQ) without ignoring the international standard.
f. Intensifying the partnership in science, technology, and engineering between science and technology professionals and economic doers.
g. Capacity building of research, development, and engineering in all disciplines of institutionally strategic science and technology.
h. Providing the support from financial sector: taxes, banking, and insurance on the utilization of domestic science and technology for industries.

CONCLUDING REMARKS

Energy technology is one of the most critical factor in facilitating and promoting economic development. It is therefore important to realize that developing countries could move away from simple import and import-substitution of consumer goods towards enhancing production capabilities through technology transfer. This is of priority in the context of the over-all strategy in the alleviation of poverty. It should be given to effective technology transfer so as to acquire along with latest technologies, know-how and the capacity to adapt technology to our needs and develop it further to achieve strong technology-base nation-wide in meeting the challenge of international competition.

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